INSTITIÚID ARD-LÉINN BHAILE ÁTHA CLIATH
(Dublin Institute for Advanced Studies)

ANNUAL REPORT
1973–74

10 Burlington Road, Dublin 4.

Prl.4458

INSTITIÚID ARD-LÉINN BHAILE ÁTHA CLIATH
(Dublin Institute for Advanced Studies)

Annual Report of the work of the Institute and its Constituent Schools presented by the Council to the Minister for Education in respect of the Financial Year 1973-74

Prl.4458

INSTITIÚID ARD-LÉINN BHAILE ÁTHA CLIATH
(Dublin Institute for Advanced Studies)

Summary of Annual Report
of the work of the Constituent Schools
for the year 1973-74

School of Celtic Studies

The vacancy left by the death of Professor Myles Dillon was at the Professor level; it was filled by the appointment of Dr. Breandán Ó Buachalla, who took up his duties on 1 December 1973.

Mr. Donald MacAulay, who was Visiting Professor during the Hilary term, held a weekly seminar on 'Aspects of the Morphology of Lewis Gaelic'. Other seminars and classes were given by Professor Ó Cuív, Mr. Fergus Kelly and Mr. Alan Ward. The Statutory Public Lecture, on 'Personal Names, Epithets and Nicknames in Irish', was delivered by Professor Brian Ó Cuív on 29 March 1974, and Professor Eric Hamp delivered a public lecture on 'The prehistory of the conjugated prepositions' on 6 February 1974.

The full report gives details of the work of research and editing carried out in their various fields by members of the School and by extern workers.

In the field of publications, four books (including periodicals) were published, one of them by the Institute; several other works were held up by printing delays. Members of the School contributed fourteen papers or shorter items to books or periodicals published elsewhere.

School of Theoretical Physics

A plaque commemorating the late Professor E. Schrödinger was unveiled by President de Valéra at 65 Merrion Square on 2nd April 1973. A reception was held and among those present were H.E. Dr. Edith Rabl, the Austrian Ambassador, and Mr. R. Burke, the Minister for Education.

The School continued its research in the areas of general relativity, statistical mechanics, Lie groups and high energy physics, and one book, and forty-three articles were published during the year. Members of the School attended six international conferences and gave twenty-four lectures in other institutions. Eighteen physicists from abroad visited the School (apart from the visitors attending the summer seminar).

Events which were continued from previous years were the Wednesday seminars, the Christmas and Easter symposia, and various weekly meetings held jointly with the universities. The joint UCD-TCD-Maynooth-DIAS postgraduate course was continued.

The international summer seminars (held in the forties and early fifties) were resumed and the subject of the opening seminar was "Current Problems in Field Theory". The seminar included three short courses by recognized leaders in Field Theory, and six review lectures by other participants. The attendance was very satisfactory consisting of about thirty visitors and fifteen locals.

A Festschrift in honour of Professor Lanczos's eightieth birthday was edited by Dr. Scaife on behalf of the Royal Irish Academy and

presented to Professor Lanczos by the Academy on 30 April 1973. The School was honoured to have as guest speaker for the occasion Professor B. J. van der Waerden of the University of ZÜrich, one of the founders of the famous GÖttingen School of Algebra.

The Statutory Public Lecture was given by Dr. A. B. Taylor of Cambridge University. It was entitled "A Mathematician in the Welding Shop" and aroused considerable interest among applied mathematicians.

School of Cosmic Physics

Astronomical Section:

Adaptation of earlier photometric techniques to the new facilities available for data-processing has advanced well during the year. Results from earlier investigations of Cepheid variables have been assessed in preparation for a detailed interpretation in terms of element abundances in the stars concerned. Light-pulse experiments of 1971 have been analysed completely and the results prepared for publication. Preparation for new observing programmes includes the testing of interferometric equipment at a large telescope, and the design and construction of 2-channel automatic data-acquisition equipment for photometric work.

Cosmic Ray Section:

The study of very heavy and ultra heavy cosmic ray nuclei in collaboration with Professor Fowler's group at Bristol University continued during the year. All the events obtained from the 1973 balloon flights have been measured and analysed. A total of 120 ultra heavy nuclei has now been accumulated, 36 of which have charge greater than 70. Although several of the events have been identified as Uranium, no transuranic nuclei have been detected to date. Two further balloon flights were carried out at Sioux Falls, South Dakota, U.S.A. in September 1973. Both of these flights were very successful and the investigation of the resulting material is well under way.

The study of the production of heavy nuclear fragments in high energy proton interactions has been extended by the use of a new technique. This work is being carried out in collaboration with the European Centre for Nuclear Research (CERN).

The study of interactions of high energy heavy cosmic ray nuclei in nuclear emulsion has been continued within the framework of the creation mechanisms for mesons and nucleons in complex nucleus collisions. The application of statistical thermodynamic theory to nuclear interactions of hadronic matter has been extended.

Various conferences and meetings were attended by members of the staff. Five papers were published during the year.

Geophysical Section:

A study of the Procupine Bank and Seabight using magnetic and seismic methods was undertaken in cooperation with the University of Wales in an attempt to elucidate their structure and hence their possible evolution. It appears that the Seabight is significantly different in character from that beneath the western Irish Mainland Shelf.

The origin of the microseismic noise observed near Malin Head mentioned in earlier reports was discovered and attributed to an unknown method of production in pockets of sand excited by passing traffic. A similar occurrence has been located in England.

Apparatus for a complete palaeomagnetic study of rocks has been set up.

An important connection between earth conductivity and Spontaneous Polarisation effects was discovered over the Dunshaughlin silica occurence.

The Kingscourt graben structure has been investigated and has proved to have been initiated in lower Carboniferous times which is much earlier than what was known.

Magnetic work in the southwest lead to the discovery of a dyke system of Tertiary age and thus extended the known limits of this volcanic activity by over three hundred kilometres.

A course of lectures on geophysics was given and attended by students from the Dublin universities. Field exercises were held in Co. Mayo for Trinity College students and in Co. Kilkenny for University College students when geophysical techniques at our disposal were demonstrated and sample surveys undertaken by students.

INSTITIÚID ARD-LÉINN BHAILE ÁTHA CLIATH
(Dublin Institute for Advanced Studies)

Annual Report of the work of the Institute and its Constituent Schools presented by the Council for the Financial Year 1973-74

In accordance with the provisions of Section 29 of the Institute for Advanced Studies Act, 1940 (No.13 of 1940), the Council of the Institute has the honour to present to the Minister for Education for submission to the Government a report of the work and activities of the Institute and its Constituent Schools for the financial year ending 31st March, 1974.

The general purpose which it is hoped to accomplish is clearly stated in the Act establishing the Institute, namely, the Institute for Advanced Studies Act, (No.13 of 1940) and in the Establishment Orders establishing the three Constituent Schools, namely, the Institute for Advanced Studies (School of Celtic Studies) Establishment Order, 1940, the Institute for Advanced Studies (School of Theoretical Physics) Establishment Order, 1940, and the Institute for Advanced Studies (School of Cosmic Physics) Establishment Order, 1947, and need not be referred to here. It is deemed desirable, however, to include in the report for the purposes of record certain particulars about the constitution of the Council of the Institute and the membership of the Governing Boards of the three Constituent Schools on the 31st March 1974.

The report is presented under the following principal heads:-

I - Constitution of the Council of the Institute and of the Governing Boards of the three Constituent Schools on the 31st March, 1974.

II - Report of the Governing Board of the School of Celtic Studies.

III - Report of the Governing Board of the School of Theoretical Physics.

IV - Report of the Governing Board of the School of Cosmic Physics.

I - Constitution of the Council of the Institute and of the Governing Boards of the three Constituent Schools on the 31st March 1974.

1. THE COUNCIL OF THE INSTITUTE

Chairman:

Professor W. B. Stanford, M.A., Litt.D., S.F.T.C.D.

Ex-Officio Members:

Thomas Murphy, M.D., D.P.H., B.Sc.Pub.H., President, University College, Dublin; Albert J. McConnell, M.A., M.Sc., Sc.D., Provost, Trinity College, Dublin; David Greene, M.A., President, Royal Irish Academy.

Members appointed by the Governing Boards of Constituent Schools:

Professor Brian Ó Cuív, M.A., D.Litt.; T. K. Whitaker, D.Econ.Sc.; Professor L. Ó Raifeartaigh, M.Sc., Ph.D.; Professor P. Quinlan, B.E., D.Sc., Ph.D.; Professor C. Ó Ceallaigh, M.Sc., Ph.D.; Professor E. F. Fahy, M.Sc., Ph.D.

2. THE GOVERNING BOARD OF THE SCHOOL OF CELTIC STUDIES

Chairman:

Right Reverend Monsignor Patrick Boylan, D.D., M.A., D.Litt.

Senior Professors:

Daniel A. Binchy, M.A., Ph.D., B.L.; David Greene, M.A.; Brian Ó Cuív, M.A., D.Litt.

Appointed Members:

Tomás de Bhaldraithe, M.A., Ph.D., D.Litt.; James H. Delargy, M.A., D.Litt., Litt.D.; Proinsias Mac Cana, M.A., Ph.D.; Edward MacLysaght, M.A., D.Litt.; Ernest Gordon Quin, M.A., F.T.C.D.; Thomas Kenneth M. Whitaker, D.Econ.Sc.

3. THE GOVERNING BOARD OF THE SCHOOL OF THEORETICAL PHYSICS

Chairman:

Albert J. McConnell, M.A., M.Sc., Sc.D., F.T.C.D.

Senior Professors:

Reverend James R. McConnell, M.A., D.Sc.; Lochlainn Ó Raifeartaigh, M.Sc., Ph.D.; John T. Lewis, B.Sc., Ph.D.

Appointed Members:

Reverend James J. McMahon, M.Sc., Ph.D.; Thomas Edwin Nevin, D.Sc.; Patrick Quinlan, B.E., D.Sc., Ph.D.; Seán Seosamh Tóibín, M.Sc., Ph.D.; Thomas David Spearman, M.A., Ph.D. (Cantab.).

4. THE GOVERNING BOARD OF THE SCHOOL OF COSMIC PHYSICS

Chairman:

Edward Francis Fahy, M.Sc., Ph.D.

Senior Professors:

Cormac Ó Ceallaigh, M.Sc., Ph.D.; Thomas Murphy, D.Sc.; Patrick Arthur Wayman, Ph.D.

Appointed Members:

Patrick M. A. Bourke, M.Sc.; Peter Kevin Carroll, M.Sc., Ph.D.; Cyril F. G. Delaney, M.A., Ph.D., F.T.C.D.; Eric M. Lindsay, M.A., M.Sc., Ph.D., F.R.A.S.; Reverend Thomas P. G. McGreevy, M.Sc., Ph.D.; Patrick J. Nolan, Ph.D., D.Sc.; Neil A. Porter, Ph.D.; Ernest T. S. Walton, M.A., M.Sc., Ph.D., D.Sc., F.T.C.D.

5. ADMINISTRATIVE STAFF

Registrar:

Patricia O'Neill.

Senior Clerk:

Maura Devoy.

Accounts Clerk:

Mary A. O'Rourke.

Clerks:

Angela Stubbs; Noreen Madden; Desmond Pender.

II - Annual Report of the Governing Board of the School of Celtic Studies for the year 1973-74 adopted at its meeting on 19 June 1974.

1. STAFF, SCHOLARS AND EXTERN RESEARCH WORKERS

Senior Professors:

David Greene, Director of the School; Daniel A. Binchy; Brian Ó Cuív.

Professors:

James P. Carney; Breandán Ó Buachalla (appointed 1 December 1973).

Visiting Professor:

Donald MacAulay (from 1 January 1974 to 31 March 1974).

Assistant Professors:

Rev. Pádraig Ó Súilleabháin, O.F.M.; Pádraig de Brún.

Junior Assistant:

Fergus Kelly.

Assistants (Part-time):

Mrs. Nessa Doran; Mrs. Anne O'Sullivan.

Research Assistant:

Rolf Baumgarten.

Research Associates:

Proinsias Mac Cana, Heinrich Wagner (to continue as Research Associates for 3 years from 1 July 1973); Gearóid Mac Niocaill (appointed for 3 years from 1 July 1973).

Technical and Clerical Staff:

Máire Breatnach; Máire Bean Uí Chinnsealaigh.

Scholars:

Ronald Black (to 30 June 1973); Máire Herbert (to 31 March 1974); Katharine Simms; Alan Ward; Liam Breathnach (appointed 1 October 1973); Michael Smith (appointed 1 October 1973); Kay Muhr (appointed 1 January 1974).

Extern Research Workers:

Dr. Cecile O'Rahilly; Louis Paul Nemo (Roparz Hemon); Dr. Ludwig Bieler; Dr. I. P. Sheldon-Williams (died 10 October 1973); Mr. Brynley Roberts; Rev. Feargal Mac Raghnaill, O.F.M.; Rev. Martin McNamara, M.S.C.; Tomás Ó Cathasaigh.

In accordance with the arrangements made when the number of Senior Professors was temporarily raised to four, the vacancy left by the death of Professor Myles Dillon was at the Professor level; it was filled by

the appointment of Dr. Breandán Ó Buachalla. The Board recommended to the Minister for Education the appointment of Mr. Rolf Baumgarten as a Bibliographical Officer on a salary scale similar to that of an Assistant Professor; this recommendation was rejected, and negotiations were still in progress at the end of the period under review. No further progress was made by the efforts to obtain a third member of the clerical staff. It is disappointing to note this lack of recognition of the necessity for ancillary staff to support those engaged in original research.

Mr. Donald MacAulay, head of the Department of Celtic in the University of Aberdeen, was Visiting Professor during the first quarter of 1974. He conducted a seminar on 'The Gaelic of Lewis' which was well attended. It must be recorded with regret that it was not possible to initiate enquiries about a Visiting Professor for the coming year, since the Board had decided to fill the vacant post of Assistant Professor which the Department of Education had regarded as providing the funds for the Visiting Professorship. No reply has yet been received to representations on this point.

It will be seen below (Section 7) that only one volume (Celtica X) was published during the year, as opposed to six in the previous year. This does not reflect any falling off in the work of the School, but only the fact that neither editors nor printers can be relied on to adhere to publication schemes. This makes a strict adherence to an allotted budget for publications quite impossible.

2. RESEARCH AND EDITING

Professor David Greene worked on: (i) an edition of Saltair na Rann of which the Adam and Eve section should shortly be ready for press; (ii) The History of the Irish Language. In collaboration with Professor Bo Almquist he has done some editing of The Proceedings of the VII Viking Congress which is due for publication in 1975. The following articles were accepted for publication:- (i) 'The Irish numerals of Cardiganshire' (Studia Celtica); (ii) 'A recent semantic shift in Insular Celtic' (ZCP); (iii) 'Distinctive plural forms in Old and Middle Irish' (Ériu); (iv) 'The preposition i n- as subject marker' (Celtica). See also Sections 6 and 7.

Professor D. A. Binchy continued work on proofs of Corpus Iuris Hibernici and saw Celtica Vol.X through the press. The following articles were accepted for publication:- (i) 'Féchem, Fethem, Aigne' (Celtica Vol.XI); (ii) 'The pseudo-historical introduction to the Senchas Már' (Studia Celtica - Thomas Jones Memorial Volume). See also Section 7.

Professor Brian Ó Cuív worked on (i) aspects of Early Modern Irish bardic poetry, including manuscript transmission and bardic teaching on grammar and metrics; (ii) a number of linguistic topics relating to Irish grammar and semantics; (iii) preparation of short texts for publication and proof-reading of works in course of production; (iv) Irish personal names, especially in the period 1000-1600; (v) material for publication as part of A New History of Ireland. Professor Ó Cuív edited two issues of Éigse and began editorial work on Celtica XI in collaboration with the Director. The following articles were accepted for publication: (i) 'Comram na Cloenfherta' (Celtica XI); (ii) 'Observations of Irish "clog" and Some Cognates' (Studia Celtica); (iii) 'The Irish Bardic Duanaire or "Poem-book"' (to be published as a pamphlet by Malvern Press). See also Sections 3, 4, 6 and 7.

Professor James Carney continued to work on the History of Gaelic Literature to 1534 for A New History of Ireland. Work on Early Irish Poetry and on the Ogam script progressed. See also Sections 6 and 7.

Professor Breandán Ó Buachalla began a general survey of the history of the Irish language and literature in Ulster c.1600-1900. See also Sections 6 and 7.

Rev. Pádraig Ó Súilleabháin, O.F.M. indexed etymological and lexicographical notes, notes on grammar and syntax, dialects, etc. For the Dictionary of Early Modern Irish he excerpted the following works: (i) Poems of Tadhg Dall; (ii) Gaelic Journal, i-viii. He verified references in the Vocabulary of Cuthbert McGrath's edition of Dán na mBráthar Mionúr and corrected proofs of the Text of Feargal Mac Raghnaill's edition of Ó hEodhusa's Teagasg Críosdaidhe. An article entitled 'Beatha Cholaim Chille: an chóip atá i LS. A 8' was accepted for publication in Celtica XI. See also Section 7.

Pádraig de Brún completed work on texts of Irish poems for the new Intermediate Certificate Course. The following articles were accepted for publication in Journal of the Kerry Archaeological and Historical Society, No.7:- (i) 'A census of the parish of Ferriter, January 1835'; (ii) 'John Windele and Father John Casey: Windele's visit to Inis Tuaisceart in 1838'; (iii) 'A monk of Ratoo'; (iv) 'Ardfert in 1827'. From 1 November 1973 to 30 June 1974 Pádraig de Brún was granted leave of absence to take courses leading to the Diploma in Archival Studies at U.C.D.

Mr. Fergus Kelly checked first proofs of the Notes of his edition of Audacht Morainn. He collated prose versions of Saltair na Rann for a forthcoming edition of 'The Story of Adam and Eve' and worked at an edition of Tiughraind Bhécáin which is to be published in Ériu XXVI. An article entitled 'The Old Irish Tree-list' was accepted for publication in Celtica XI. See also Sections 4, 6 and 7.

Mrs. Nessa Doran completed the preparation of Fasc.III of A Catalogue of Irish MSS. in the NLI. At the suggestion of Professor Ó Cuív some of the material was revised before going to Press. MSS. G115-129, G133-4 have been catalogued for Fasc.IV.

Mrs. Anne O'Sullivan checked first proofs of Professor Binchy's edition of Corpus Iuris Hibernici with the following manuscripts: Rawl. B 487; B 506; TCD E 3.5; H 4.22; H 3.17; RIA 23 Q 6; 23 P 3; 23 P 12; BM Eg. 90. An article on the Tinnakill Duanaire was accepted for publication in Celtica XI. See also Section 7.

Mr. Rolf Baumgarten continued to collect and arrange entries for the Bibliography of Irish Linguistics and Literature. All items of R. I. Best's Bibliography of Irish Philology and Literature, Parts I and II were transferred on to cards with the assistance of Miss Cathleen Sheppard. He compiled a bibliography of the publications of the late Professor Myles Dillon and this has been accepted for publication in Celtica XI. See also Sections 6 and 7.

Professor Proinsias Mac Cana, as General Editor of the Medieval and Modern Welsh Series, read first proofs of the Introduction and Text of Brynley Roberts's edition of Cyfranc Llud a Lleyelys, which will be published as volume vii of the Series.

Dr. Gearóid Mac Niocaill read first proofs of part of the Post-Patrician Translation and Text of The Annals of Ulster. Further progress on this work has been held up due to the delay by the printer in providing proofs of material submitted in September 1972.

Mr. Ronald Black did some preparatory work editing and translating some Scottish bardic poetry in RIA and NLS collections. He made a preliminary examination of all classical Gaelic MSS. in NLS and Nat.Mus. Antiq. Scotland with a view to establishing date and provenance and numbered the hands for identification and comparison. He studied sources of Scottish MS. collections and prepared a summary catalogue of 13 late Classical MSS. and submitted descriptions of 6 MSS. to the Institute. The following articles were accepted for publication: (i) 'Poems by Maol Domhnaigh Ó Muirgheasáin' (Scottish Gaelic Studies); (ii) 'Colla Ciotach' (Transactions of Gaelic Society of Inverness). See also Section 7.

Miss Máire Herbert worked on the Legend of St. Columcille in early Irish literature and edited poems relating to the Life of Columcille in MS. Laud Misc. 615. A catalogue of Irish MSS. in Cambridge University Library is in progress. See also Section 7.

Miss Katharine Simms continued to work on her Ph.D. thesis 'Gaelic Lordships in Ulster in the Later Middle Ages'. She assisted Professor Brian Ó Cuív in the preparation of a catalogue if Irish bardic poetry. An article entitled 'The Archbishops of Armagh and the O Neills 1347-1471'

was accepted for publication in Irish Historical Studies. See also Section 6.

Mr. Alan Ward completed his Ph.D. thesis 'The grammatical structure of Munster Irish' and did some field work for Dialect Survey in Munster Gaeltachtaí. An article entitled 'Deilbhíocht an ainmfhocail i gcanúintí na Mumhan' was accepted for publication in Ériu. See also Sections 4, 5 and 7.

Mr. Liam Breathnach worked on the suffixed pronouns of Old Irish for his M.A. thesis which is to be presented at U.C.D.

Mr. Michael Smith investigated the syntax and semantics of the Old Irish definite article.

Miss Kay Muhr commenced work on the preparation of an edition of the Middle Irish tale 'Airecc Menman Uraird maic Coise', under the supervision of Professor Carney.

M. Louis Paul Nemo continued to work on the Historical Dictionary of Breton and read first proofs of A Historical Morphology and Syntax of Breton. An article on 'The Diminutive Suffixes in Breton' was accepted for publication in Celtica XI. See also Section 7.

Dr. Cecile O'Rahilly completed the preparation of the Text, Translation and Notes of an edition of TBC Recension I. The following articles were accepted for publication:- (i) 'Cess Naíden' (Éigse XV); (ii) Cathcharpat Serda (Celtica XI). See also Section 7.

Dr. Ludwig Bieler as General Editor of Scriptores Latini Hiberniae, has undertaken, in collaboration with Professor J. J. O'Mara, to revise the final draft of the late Dr. I. P. Sheldon-Williams's edition of Periphyseon (de Divisione Naturae) Liber III. Dr. Sheldon-Williams, who died on 10 October 1973, donated his entire Eriugena apparatus to the Classics Department of U.C.D. This contains, inter alia, a large amount of drafts and other preparatory material for the edition of Books IV and V of Periphyseon. Arrangements are to be made for editing these books with the help of the materials mentioned and thus complete the edition. Preparation of Dr. Bieler's edition of Muirchú, Tírechán and the other Patrician texts in the Book of Armagh (except the Confessio) has been completed and, after a final revision, will be submitted for publication. Dr. M. P. Sheehy continued work on his edition of Collectio Canonum Hibernensis, but owing to the considerable difficulties of the text and its complex transmission progress will be slow.

Mr. Brynley Roberts read first proofs of the Text and Introduction of his edition of Cyfranc Lludd a Llefelys which is to be published as volume vii in the Medieval and Modern Welsh Series.

Rev. Feargal Mac Raghnaill, O.F.M. checked first proofs of his edition of Ó hEódhusa's Teagasg Críosduidhe which will be published in the series Scríbhinní Gaeilge na mBráthar Mionúr.

Rev. Martin McNamara, M.S.C. checked revised proofs of The Apocrypha in the Irish Church and these were returned to the printer for further revise.

Tomás Ó Cathasaigh read first proofs of the Text, Introduction, Notes and Variant Readings of The Heroic Biography of Cormac mac Airt.

3. LECTURES

Professor Eric Hamp of the University of Chicago delivered a public lecture on 'The prehistory of the conjugated prepositions' on 6 February 1974.

A statutory public lecture entitled 'Personal Names, Epithets and Nicknames in Irish' was delivered by Professor Brian Ó Cuív in Trinity College, Dublin, on 29 March 1974.

4. SEMINARS

Professor Brian Ó Cuív held (i) a seminar on Early Modern Irish Grammar and Bardic Linguistic Training in the Michaelmas term 1973; (ii) a weekly class on manuscript reading and textual editing in the Michaelmas and Hilary terms 1973-74.

Mr. Alan Ward held a seminar on 'Dearcadh stairiúil ar dheilbhíocht an ainmfhocail i nGaeilge Chúige Mumhan' in the Michaelmas term 1973.

Mr. Fergus Kelly held a seminar on Tiughraind Bhécáin - a 7th century poem in praise of Columb Cille - in the Hilary term 1974.

Mr. Donald MacAulay held a weekly seminar on 'Aspects of the Morphology of Lewis Gaelic' in the Hilary term 1974.

5. SYMPOSIUM

On March 29 and 30 1974 a symposium was held for university and college staffs and research workers. The following papers were read:-

Gordon Mac Gill Fhinnein: Fadhbanna Gaidhlig.

Domhnall Ó Baoill: Deixis sa Nua-Ghaeilge.

Alan Ward: The sentence-type Cá bhfuil na leanaí, a Bhríde, imithe? in Munster Irish.

Donald MacAulay: Types of predication in Scottish Gaelic.

Máirtín Ó Murchú: Deilbhíocht an ainmfhocail i nGaidhlig Shíorramachd Pheairt.

Seosamh Watson: Cailliúint an ghuta [ə] i gcanúint de chuid Oirthear na hAlban.

Terence McCaughey: Possessive in Scottish Gaelic.

Eric Hamp: The semantics of 'good' and 'bad' in Gaelic.

Tomás de Bhaldraithe: An Diabhal i gcomhréir na Gaeilge.

6. EXTERNAL ACTIVITIES

Professor David Greene was elected President of the Royal Irish Academy on 16 March 1973. He acted as Chairman of the Seventh International Viking Congress held in Dublin in July 1973. On 19 July 1973 he lectured to the Congress on 'The Influence of Scandinavian on Irish'. At Trinity College, Dublin, on 10 April 1973 Professor Greene delivered a lecture on Saltair na Rann and on 22 October 1973 he delivered the Presidential Address to the Royal Irish Academy.

Professor Brian Ó Cuív delivered the R. I. Best Memorial Lecture on 'The Irish Bardic Duanaire or Poem-book', at the National Gallery of Ireland on 24 May 1973.

Professor James Carney lectured on "Early Irish Literature" to the School of Irish Studies, Wilton Place, Dublin on 31 October 1973 and on 'The formation of Ogam Script' to the School of Theoretical Physics of the Institute on 20 March 1974.

Professor Breandán Ó Buachalla, under the auspices of the Irish-American Cultural Institute, lectured at several American universities on 'Irish Literature' from 15 March to April 1974.

Mr. Fergus Kelly delivered a lecture on 'Early Irish Wisdom', under the auspices of the Philosophical Society and Cumann Gaelach of Trinity College, at Trinity College, Dublin on 13 April 1973 and on 6 November 1973 at Boyle, Co. Roscommon he lectured on 'Early Irish Life'.

Mr. Rolf Baumgarten lectured on 'Early Irish names and native etymology' to An Cumann Logainmneacha at University College, Dublin on 21 March 1974.

Miss Katharine Simms lectured on 'The Annals of Loch Cé' to the Past Pupils Union of St. Mary's College, Boyle, Co. Roscommon on 4 May 1973 and on 15 March 1974 she delivered a lecture on 'Niall Garbh O Donnell, King of Tír Conaill 1422-39' to the Co. Donegal Historical Society in the Vocational School, Donegal.

7. PUBLICATIONS

(a) Books published by the Institute:

Celtica Volume X. Edited by Myles Dillon.
pp.274. Price £4.00. Published March 1974.

(b) Books published outside the Institute:

David Greene:

Ériu XXIV. Published by the Royal Irish Academy and edited by David Greene and Proinsias Mac Cana.

Roparz Hemon:

Historical Dictionary of Breton: Rann XXI. (Lavarout - Louzus)
Published by Etienne, Paris. pp.2001-2100.

Brian Ó Cuív:

Éigse XV, Parts 1 and 2. Published by the National University of Ireland and edited by Brian Ó Cuív.

(c) Contributions to Periodicals:

David Greene:

Synthetic and Analytic: a reconsideration. Ériu XXIV, 121-133.

D. A. Binchy:

Distraint in Irish Law. Celtica X, 22-71.

A text on the forms of distraint. ibid. 72-86.

MacNeill's Study of the Ancient Irish Laws. The Scholar Revolutionary (ed. F. X. Martin and F. J. Byrne), 39-48.

Brian Ó Cuív:

Two Items from Irish Apocryphal Tradition. Celtica X, 87-113.

The Linguistic Training of the Mediaeval Irish Poet. ibid. 114-40.

Roinnt Leasaithe Téscs. Éigse XV, 13-21.

A Poem on the Infancy of Christ. ibid. 93-102.

A Passage in Aided Con Culainn. ibid. 140.

The Motif of the Threefold Death. ibid. 145-50.

Reviews. ibid. 81-8, 152-5, 160-72.

MacNeill and the Irish Language. The Scholar Revolutionary, (ed. F. X. Martin and F. J. Byrne), 1-10.

James Carney:

Society and the Bardic Poet. Studies. Autumn/Winter 1973.

Breandán Ó Buachalla:

Dán ar Chath Eachroma. Éigse XV, 117-23.

Pádraig Ó Súilleabháin, O.F.M.:

Nótaí ar thrí fhocal ó na hAnnála. Éigse XV, 22-23.

Pádraig de Brún:

Two Bréifne Manuscripts. Breifne 1972, 426-47.

Review: Cín lae Amhlaoibh (T. de Bhaldraithe). Éigse XV, 151-2.

Fergus Kelly:

A Poem in Praise of Columb Cille. Ériu XXIV, 1-34.

Anne O'Sullivan:

The Provenance of Laud Misc. 615 (with M. Herbert). Celtica X, 174-192.

Review: Gaelic Folktales and Mediaeval Romance (A. Bruford). ibid. 267-71.

Rolf Baumgarten:

Edition of M. A. O'Brien's 'Old Irish Personal Names'. Celtica X, 211-36.

Celtic lemmata. Brockhaus Enzyklopädie.

Ronald Black:

A Manuscript of Cathal Mac Muireadhaigh. Celtica X, 193-209.

Review: The Gaelic Notes in the Book of Deer. (K. H. Jackson). ibid. 264-7.

Máire Herbert:

The Provenance of Laud Misc. 615 (with A. O'Sullivan). Celtica X, 174-192.

Alan Ward:

Will and Testament in Irish. Ériu XXIV, 183-185.

Cecile O'Rahilly:

Five Notes. Celtica X, 141-50.

III - Report of the Governing Board of the School of Theoretical Physics for the year 1973-74 adopted at its meeting on 23 August 1974.

1. STAFF AND SCHOLARS

Emeritus Professors:

Cornelius Lanczos; John L. Synge.

Senior Professors:

Rev. James R. McConnell; Lochlainn S. Ó Raifeartaigh, Director for three years from 10 January 1972; John T. Lewis.

Visiting Professors:

A. Schild (20-27 May 1973); P. M. Mathews (20 June - 17 July 1973); B. Sredniawa (6-31 July 1973); J. Nilsson (18 July - 14 August 1973); M. Sachs (August 1973); B. Sz.-Nagy (4-16 March 1974).

Assistant Professor:

R. Acharya.

Research Associates:

D. Judge, D. McCrea, S. Dineen (UCD); P. S. Florides, B. K. P. Scaife (TCD); A. I. Solomon (Open University); P. D. McCormack (UCC); D. H. Tchrakian (Maynooth) - appointments continued to 30 September 1975. J. M. Golden (Kevin St. College of Technology) appointed 1 October 1973 to 30 September 1975.

Scholars:

P. de Baenst (without stipend, left September 1973); J. Gomatam (left September 1973); S. Browne (without stipend, left September 1973); P. Hogan (left September 1973); B. Mainland; E. Harper; Z. Horvath; A. O'Connor; T. Garavaglia (without stipend); E. Manoukian (appointed 1 October 1973); W. Sullivan (appointed 1 October 1973).

Research Students without stipend:

P. Sisson, J. Ziegler; T. Sherry (appointed April 1973); P. Berner (appointed October 1973); R. Critchley (left September 1973).

Secretary and Assistant Librarian:

Evelyn R. Wills.

2. GENERAL

(a) A plaque commemorating the late Professor E. Schrödinger was unveiled by President de Valéra at 65 Merrion Square on 2nd April 1973. A reception was held, and among those present were H.E. Dr. Edith Rabl, the Austrian Ambassador, and Mr. R. Burke, the Minister for Education.

(b) A Festschrift to celebrate Professor Lanczos's 80th birthday was prepared by Professor Scaife and presented to Professor Lanczos by

the Royal Irish Academy on 30th April 1973.

(c) A summer seminar on "Current Problems in Quantum Field Theory" was held in St. Patrick's Training College, Drumcondra, from 9th to 13th July 1973. It was attended by approximately fifteen local physicists and thirty visitors from overseas. A decision was taken to hold a similar seminar on "Current Problems in Particle Physics" in July 1974.

3. STUDY AND RESEARCH

Professor Lanczos continued his researches in gravitation and Riemannian space, symmetry and the principles of geometry.

Professor Synge did some preliminary work on the problem of relativistic gravitational collapse, using null coordinates. He also studied Newtonian models of globular clusters in which the stars are regarded as forming a gas without collisions, so that the Liouville equation is central. He created a stationary model with hollow centre, in which the total energy of a particle is bounded above and its angular momentum bounded below.

Dr. McCrea worked on the construction of exact models of static axially symmetric shells, using the methods of Israel et al., and constructed, in collaboration with an M.Sc. student, models in which several exterior vacuum axisymmetric metrics are matched to interior Minkowskian metrics. He is now investigating the detailed properties of these models.

Dr. Florides continued to work in general relativity, in particular on a new interior Schwarzschild solution of the Einstein equations.

Dr. Hogan completed work on the equation of motion, and on the radiation of 4-momentum in classical electrodynamics, commenced in the previous year. He then began to study relativistic kinetic theory.

Professor Ó Raifeartaigh's work during the year was mainly on unified gauge theory, a subject which is currently of great interest in particle physics as it allows a unification of weak interaction and electromagnetic theory. In this work he collaborated with Dr. Mainland, and two joint papers and a letter on their work are in course of publication. Professor Ó Raifeartaigh's teaching activities included the symmetry part of the M.Sc. course for the universities in the Dublin area, and assistance to one M.Sc. and one doctoral student in their theses.

During the first part of the year Dr. Tchrakian continued investigations in gravitational radiation, which he had begun in 1972. He considered the expression of the analogies between electrodynamical and gravitational interactions as classical fields, and developed a formulation of linearised gravity on these lines. Two articles on this subject have now been sent for publication. During the second part of

the year Dr. Tchrakian developed a method for constructing covariant bases for two particle massive reactions, and is now preparing this work for publication.

Dr. Manoukian studied the short-distance behaviour of quantum electrodynamics in the presence of neutral-meson theory with ps-ps coupling proceeding loop-wise. He showed that the Adler-Baker-Johnson eigenvalue condition for the fine-structure constant alpha remains stable in the presence of strong dynamics. This result suggests that the value of alpha possibly may be determined within pure electrodynamics in isolation from the rest of the world. As a by-product of this work he discovered that the effective strong coupling in this abelian gauge theory vanishes at very high energies faster than the presently estimated ones in non-abelian theories. He has prepared this work for publication.

Dr. Gomatam and Mr. Garavaglia collaborated on a quantum description of DNA, and also in work on the Schrödinger equation in helical coordinates, and prepared papers on these topics for publication. Mr. Garavaglia is presently studying quantum electrodynamics, and also the quantum properties of helical molecules.

Mr. Browne studied the conditions under which a relativistically invariant first order wave equation will describe a particle with unique mass and unique spin; he found necessary and sufficient conditions and stated them in terms of beta-matrices occurring in these equations. He also studied conformal properties of an arbitrary Lagrangian field theory.

Dr. Acharya and Dr. Horvath studied a nonclassical theory of magnetic monopoles originally proposed by J. G. Taylor (Phys.Rev.Lett. 18 (1967), 713), and re-examined it in the framework of the spontaneous breakdown of a $U_L(1) \times U_R(1)$ gauge model. The conjecture of Taylor that the Dirac-Schwinger quantization condition breaks down after spontaneous breakdown of this aforementioned symmetry was explicitly demonstrated, and published. Drs. Acharya and Horvath also studied the possibility of a microscopic determination of the fine structure constant and of the electron-muon mass ratio within the realm of quantum electrodynamics, using the recent method of S. Weinberg (Phys.Rev. 8D) (1973, 3497) for the renormalization group. In this framework Dr. Acharya and Dr. Horvath conjectured that the electron-muon mass ratio and the fine structure constant are solutions of Weinberg's equation at a fixed-point. This work is now in press. Drs. Acharya and Horvath constructed a nonperturbative, scale-invariant field theory model exhibiting the property that the underlying quark-gluon sub-structure remains totally unobservable, despite interaction. The model possesses composite Goldstone bosons which could, in principle, couple strongly to the quarks to generate possible bound state hadrons.

The relationship between this model and the massless limit of the Adler-Baker-Johnson-Willey model was discussed to show that the two models are quite distinct. This work also has been submitted for publication.

Professor McConnell completed his investigations of weight diagrams for representations of Lie algebras of the orthogonal and symplectic groups, and of their use in the reduction of representations of the general linear group. He continued his collaboration with Dr. M. J. Newell, President of University College, Galway, on the theory of group characters and on properties of Schur functions.

Dr. Solomon worked on the application of Lie algebraic methods to linear lattice models of thermodynamic systems and generalized the X-Y model to a hierarchy of algebraically equivalent, exactly solvable models involving long-range and many-body forces.

Professor Lewis continued his work in statistical mechanics. His work on Brownian motion simulated by a heat bath, carried out in collaboration with Dr. L. C. Thomas (Swansea) led to a characterization of stationary Hilbert-space-valued stochastic processes satisfying linear stochastic differential equations. The proof of this result is in press. The result is being used to analyse models of Brownian motion. He collaborated with Professor Scaife on a problem in dielectric relaxation, and also continued to work on equilibrium statistical mechanics. In collaboration with Mr. Sisson he investigated the equilibrium states of a C*-algebra associated with the two-dimensional Ising model, and in collaboration with Mr. Critchley the entropy density of quasi-free states of boson systems.

Dr. O'Connor continued his work on heat conduction properties of the disordered chain. This work has led to two papers, one (published) in collaboration with Professor J. L. Lebowitz (Yeshiva). He has also continued work on a number of questions in quantum mechanics, in collaboration with Dr. J. M. Combes (Toulon), including the finiteness of the number of bound states of negative ions.

Dr. Sullivan studied Markov evolution of random fields as models for the time development of Ising-like systems. He obtained results for mean square convergence, for "attractive" evolution and for convergence in the weak interaction case, and has prepared two papers on these results for publication.

Mr. Ziegler has been studying Boltzmann's ideas on the approach to equilibrium in statistical mechanics. Using a suggestion of Dr. Sullivan's, he has developed a modified Ehrenfest Model with a stable equilibrium distribution. He investigated in detail the Ehrenfest-Boltzmann conjectures in this model.

Dr. Harper continued his studies of the trinucleon scattering systems. He completed his calculations of the nucleon-deuteron low

energy scattering parameters by applying the unitary-pole-expansion to the two-body system and using Pade approximants to solve the Faddeev three-body equations. A description of this work, and the results, is now being published. He is now extending this work to cover the intermediate energy region, and to calculate phase shifts, inelasticity parameters and polarization parameters in nucleon-deuteron elastic scattering and break-up. He is also preparing for publication preliminary results of the application of one-hadron-exchange potentials to the three nucleon bound system.

Dr. Golden worked on atmospheric physics, and calculated the rate of diffusion of particles through air containing absorptive centres for these particles; he prepared this work for publication. He also studied gauge models and scale invariance.

Professor Scaife completed the editing and correction of page proofs of the Lanczos Festschrift - Studies in Numerical Analysis.

Dr. Dineen extended and generalised his previous work on the applications of surjective limits to infinite dimensional holomorphy, and, in collaboration with Dr. Noverrez (Nancy), developed the concepts of strongly separable and sigma-convex locally convex spaces.

Mr. Berner studied the problem of generalising the sigma bar problem to Banach spaces, and also holomorphy on surjective limits of locally convex spaces, with particular attention to inductive limit topologies on spaces of holomorphic mappings, problems of global factorization, and the Levi problem for domains spread.

4. SEMINARS AND REVIEW LECTURES

Review and Seminar lectures were held throughout the year, and as in previous years they were attended by members of staff and students from Trinity College, Dublin, University College, Dublin, and St. Patrick's College, Maynooth, as well as by members of the School of Cosmic Physics.

The following Seminars were given:

Professor N. L. Balazs (SUNY Stony Brook): A theory of lasers.

Dr. F. Bloore (Liverpool): Lagrangian quantum theory.

Professor J. Carney (DIAS): Composition of the Ogham script.

Professor J. M. Charap (Queen Mary Coll.): A gauge theory of conformal invariance.

Professor W. G. Dixon (Cambridge): Gravitational radiation via Green's functions.

Mr. T. Garavaglia (DIAS & Kevin St. Tech.) & Dr. J. Gomatam (DIAS): Towards a quantum description of DNA.

Dr. E. Harper (DIAS): Recent progress in trinucleon calculations based on Faddeev's equation.

Dr. A. Joseph (Tel-Aviv): Algebraic structure in field theory.

Professor C. Lanczos (DIAS): The quadratic action principle of relativity.

Dr. V. McBrierty (TCD): Study of polymer properties and their theoretical description.

Professor J. R. McConnell (DIAS): Weight diagrams for compact simple Lie algebras of rank three.

Dr. B. Mainland (DIAS): Review of Lee model and introduction of vector bosons.

Dr. E. Manoukian (DIAS): Stability of eigenvalue condition for e^2/hc.

Professor P. M. Mathews (Madras): Aspects of non-linear field equations.

Causality of propagation of relativistic fields.

Dr. M. Mortell (UCC): One-dimensional non-linear waves in a bounded medium.

Professor B. Sz.-Nagy (Budapest): Dilations of semigroups of contractions on Hilbert space.

Representations of the canonical commutation relations.

Dr. N. Ó Murchadha (Princeton): Existence and uniqueness of solutions to the Hamiltonian constraint of general relativity.

Dr. R. G. Roberts (Rutherford Lab.): Diffraction of multiparticle production.

Dr. D. Ross (Imperial Coll.): Renormalization of a spontaneously broken gauge theory.

Professor B. K. P. Scaife (TCD & DIAS): Problems in the theory of dielectrics (2 lectures).

Professor J. Scanlan (UCD): Topics in network synthesis (4 lectures).

Professor A. Schild (Texas): "Action-at-a-distance" theories with self-action.

Dr. S. Sen (TCD): Report on the Aix-en-Provence high energy conference.

Dr. D. Simms (TCD): Kostant-Souriau quantization.

Professor T. D. Spearman (TCD): Zeros in scattering amplitudes.

Dr. W. Sullivan (DIAS): Evolution of Markov chains and fields and the possibility of metastable states.

Professor B. L. van der Waerden (Zurich): The foundation of quantum mechanics.

5. COURSES

The M.Sc. courses provided jointly by the Universities in the Dublin area and the Institute were continued. The Institute's contribution was provided by Professor Ó Raifeartaigh who lectured during the Michaelmas and Hilary terms on "Symmetry groups in quantum theory". The informal course on "Recent developments in statistical mechanics", which was begun by Professor Lewis last year, was continued during the Michaelmas term. A course of four lectures on Markov random fields and Gibbs states was given by Dr. C. Preston (Oxford).

In the Hilary term Professors McConnell and Lewis organized the following course of lectures on non-equilibrium statistical mechanics:

J. T. Lewis: The Boltzmann equation (2 lectures).
The Ehrenfest model.
Dynamical theories of Brownian motion.
A. J. O'Connor: The master equation (2 lectures).
C. Lanczos: Einstein's theory of Brownian motion.
B. K. P. Scaife: Brownian motion and dielectric relaxation.

6. STATUTORY PUBLIC LECTURE

A Statutory Public Lecture, under the auspices of the School, was delivered in University College, Dublin, on "A mathematician in the welding shop", by Dr. A. B. Taylor, on 11 January 1974.

7. VISITORS

For lectures given by Visiting Professors and other Visitors see Sections 3, 4, 5 & 6.

Professor N. L. Balazs (SUNY Stony Brook) 16 January 1974.
Dr. F. Bloore (Liverpool) 9 May 1973.
Professor J. M. Charap (Queen Mary College) 31 October 1973.
Professor W. G. Dixon (Cambridge) 29-31 May 1973.
Dr. A. Joseph (Tel-Aviv) 10 September - 6 October 1973.
Dr. A. Klotz (Sydney) 17 May - 17 August 1973.
Professor P. M. Mathews (Madras) 20 June - 17 July 1973.
Professor B. Sz.-Nagy (Budapest) 4-16 March 1974.
Professor J. Nilsson (Goteborg) 18-31 July 1973.
Dr. N. Ó Murchadha (Princeton) 16 May 1973.
Dr. C. Preston (Oxford) 17-18 January 1974.
Dr. R. G. Roberts (Rutherford H.E.L.) 23 January 1974.
Dr. D. Ross (Imperial College) 20 February 1974.
Professor M. Sachs (SUNY Buffalo) 1-31 August 1973.
Professor A. Schild (Texas) 20-27 May 1973.
Professor B. Sredniawa (Cracow) 6-31 July 1973.
Dr. A. B. Taylor (Oxford) 10-12 January 1974.
Professor B. L. van der Waerden (Zurich) 29 April - 3 May 1973.

8. SYMPOSIA

Two mathematical symposia were held - on 2-3 April and on 17-18 December 1973. The attendances (39 in April, 51 in December) included

Professors, Lecturers, and Graduate Students from the several Irish universities.

In addition to the short communications (previews), the following lectures were delivered:

April:

Dr. R. Aron (TCD): Convolution operators on entire functions.

Dr. T. Hurley (Sheffield): Why represent a group?

Professor J. Flavin (UCG): Aspects of Saint-Venant's principle.

Dr. W. Montgomery (Open U.): Dynamical Lie algebras.

Dr. A. I. Solomon (Open U. and DIAS): Lie algebraic approach to spin models.

Dr. B. Quigley (UCD): Representations of compact Lie groups.

December:

Professor E. F. Fahy (UCC): A problem on radar-echo times in a uniform gravitational field.

Dr. R. Harte (UCC): The spectral mapping theorem in many variables.

Dr. S. Dineen (UCD & DIAS): An algebraic approach to spectral theory in several variables.

Professor J. Miller (TCD): Algorithms for finding the type of a polynomial.

Dr. T. Garavaglia (Kevin St. Tech. & DIAS): Non-linear electromagnetic interactions in quantum electrodynamics.

Dr. F. Gaines (UCD): A characterization of composition algebras.

9. WORKING SEMINAR

A working seminar on Current Problems in Quantum Field Theory was held at St. Patrick's College, Drumcondra, 9-13 July 1973. There were 31 participants from abroad, and 16 local participants. The programme included three courses of three lectures each, and six review lectures, as follows:

Courses:

Professor B. Simon (Princeton): Quantum field theory as an Ising model.

Dr. R. Streater (London): Scattering of spin waves and Bloch walls.

Professor I. Todorov (Sofia): Conformal invariance and short-distance behaviour.

Reviews:

Professor R. Racza (Warsaw): Construction of interacting scalar field, satisfying the covariance, asymptotic and spectral conditions.

Dr. W. Faris (Battelle, Geneva): Adding self-adjoint operators.

Dr. H. Bacry (Marseilles): Infinite component field as composite model.

Dr. E. Davies (Oxford): The Dicke maser model.

Dr. K. Schmidt (London): Newman's construction of 2-dimensional Markov fields.

Dr. O. Melsheimer (Marburg): On the relationship between macro- and micro- physical theories.

10. EXTERNAL ACTIVITIES

Professor Synge lectured to the Institute of Physics, in Galway, on 8 April 1973 on "The science explosion"; to the Dublin University Mathematical Society on 16 April on "Linked harmonic oscillators"; and to the Irish Mathematics Teachers Association on 17 May on "The thrown string: a problem in probability".

Professor McConnell spent two months in the period October-December 1973 at the State University of New York at Stony Brook. During that period he visited physics and mathematics departments of the State University of New York at Buffalo, the University of Toronto and Laval University, Quebec, and gave seminars there. He also visited and had discussions at the Rockefeller University, New York, and the University of South Florida, Tampa. He attended the Twelfth Eastern Conference on Theoretical Physics at Blacksburg, Virginia, 25-27 October.

Professor Ó Raifeartaigh attended the Second International Colloquium on Group Theoretical Methods in Physics, which was held at the University of Nijmegen, Netherlands, in June 1973, and gave a talk there on unified gauge theory. He attended the Annual Rutherford H.E.L. Conference on High Energy Physics in January 1974. In March he attended, and gave a rapporteur talk on unified gauge theory and asymptotic freedom at, the First Meeting of the European Mathematical Physics Society in Warsaw. He gave this talk also at the Physics Institute in Prague.

Professor Lewis took part in a rencontre between mathematicians and chemists organized by the Science Research Council, at Oxford, 6-8 April 1973. In November he gave seminars on his work at Birmingham, Oxford, and Bedford College, London. He talked to student societies at UCD and St. Patrick's College, Maynooth, on paradoxes of statistical mechanics. He gave an Invited Talk to the Irish Branch of the Institute of Physics, at Newcastle, Co. Down, on 30 March 1974, on "Current research in statistical mechanics".

Dr. O'Connor gave a talk at Bedford College Meeting on Statistical Mechanics in December 1973, and at the Open University in March 1974, on the topic of disordered chains.

Professor Scaife lectured at the 1973 Meeting of the Dielectrics Society, at Oxford in April, on "Double layers".

Dr. Dineen attended the International Conference on Infinite Dimensional Holomorphy, at Lexington, Kentucky, in May 1973, and gave a lecture there. He visited Poland for 8 days in March 1974, on the

invitation of the Polish Academy of Sciences: he lectured in Warsaw and Cracow, and had discussions there with a number of Polish functional analysists.

Dr. Solomon participated in the Second International Colloquium on Group Theoretical Methods in Physics, held at Nijmegen in June 1973. He gave a talk on "Generalized Ising Model" at Oxford in November, and on "Models for ferromagnets" at the Open University in February 1974.

11. PUBLICATIONS

Items marked with an asterisk were recorded as in press in previous reports.

(1) Books:

Published:

Talking about relativity. By J. L. Synge (North-Holland, 1970) - translated into Japanese (Kaigai Hyoron-sha, Tokyo) and into Polish (Państwowe Wydawnickwo Naukowe, Warsaw), 1974.

In the press:

*The Einstein decade: 1905-1915. By C. Lanczos. Paul Elek Scientific Books, London.

*Festschrift for Professor Lanczos's 80th birthday. Ed. by B. K. P. Scaife. Academic Press.

(2) Contributions to periodicals and other publications:

Published:

C. Lanczos:

*Emmy Noether and the calculus of variations. Bull.Inst.Math. Appl. 9 (1973), 253-58.

*Legendre versus Chebyshev polynomials. Dublin Symposium on Numerical Analysis, 1972, 191-201.

Computing through the ages. Dublin Symposium on Numerical Analysis, 1972, 1-12.

Vector potential and Riemannian space. Found.Phys. 4 (1974), 137-47.

J. L. Synge:

*Linked harmonic oscillators. Dedicated to W. Prager on his 70th birthday. SIAM J.Appl.Math. 25 (1973), 335-45.

*Model universes with spherical symmetry. In honour of B. Segre on his 70th birthday. Ann.Mat.pura e appl. (6) 98 (1974), 239-55.

*A steering problem. Q.Appl.Math. 31 (1973), 295-302.

*The general theory of relativity. Hermathena No.115 (1973), 57-71.

What is a geodesic? Crystal (UCG Science Society) 1973, pp.13-15.

Review of J. Agassi "Faraday as a natural philosopher", Chicago U.P., 1971. Phil.Soc.Sci. 3 (1973), 351-4.

P. A. Hogan:

*A note on the escape of neutrinos from within a thick spherical shell. Proc.R.I.A. 73A (1973), 91-97.

*Electrodynamics without advanced fields or asymptotic conditions. Nuovo Cim. 15B (1973), 136-46.

*The physical consequences of the Huggins term in classical electrodynamics. Nuovo Cim. 16B (1973), 251-63.

*Huggins-renormalised electrodynamics: A system of charged particles. Nuovo Cim.Lett. 7 (1973), 135-38.

Classical electrodynamics: the equation of motion. Proc. Camb.Phil.Soc. 76 (1974), 359-69.

P. A. Hogan and D. J. McCrea:

*The equations of motion of macroscopic bodies in general relativity. GRG 5 (1974), 79-113.

S. Banerji:

Some general theorems in Brans-Dicke and Hoyle-Narlikar cosmologies. Phys.Rev. 9D (1974), 877-82.

P. Yodzis:

*On the expansion of closed universes. Proc.R.I.A. 74A (1974), 61-6.

*Lorentz cobordism, II. GRG 4 (1973), 299-307.

P. S. Florides:

A new interior Schwarzschild solution. Proc.Roy.Soc. 337A (1974), 529-35.

J. McConnell:

*Reduction of representations of the general linear group using Lie algebras. J.Appl.Math. 25 (1973), 287-99.

*Weight diagrams for Lie algebras of rank three. Proc.R.I.A. 73A (1973), 195-212.

*Critical notice of "Scientific knowledge and its social problems" by J. R. Ravetz, Oxford, Clarendon Press, 1971. Phil.Studies 21 (1973), 221-24.

J. McConnell and M. J. Newell:

*Expansion of symmetric products in series of Schur functions. Proc.R.I.A. 73A (1973), 255-74.

W. Montgomery and L. Ó Raifeartaigh:

*Non-compact Lie-algebraic approach to the unitary representations of SU(1,1): role of the confluent hypergeometric equation. J.Math.Phys. 25 (1974), 380-82.

U. Niederer and L. Ó Raifeartaigh:

*Mackey-Wigner and covariant group representations. Proc.NATO Summer School, Istanbul, 1970. Studies in mathematical physics, ed. by O. Barut, Reidel 1973. pp.155-77.

G. B. Mainland and L. Ó Raifeartaigh:

*Fixed point theorem for the Poincaré group. Internat.J.T.P. 8 (1973) 465-71.

G. B. Mainland and L. Ó Raifeartaigh:

Reduction of the Weinberg Lagrangian to a simple model. Proc. 2nd Internat.Conf. on Group Theoretical Methods in Physics, I, Univ. of Nijmegen Press (1973), pp.A147-165.

J. Gomatam, D. Tchrakian and L. Ó Raifeartaigh:

*Simple calculation of Wigner angles. Math.Theor.Phys. (USSR), 19 (1974) 201-207.

A. Böhm and G. B. Mainland:

Generalizations of the Dirac equation. Nuovo Cim. 18A (1973), 308-26.

R. Acharya and P. A. Hogan:

*Equivalence of massive Brans-Dicke and Einstein theories of gravitation. Nuovo Cim.Lett. 6 (1973), 668-72.

R. Acharya and Z. Horvath:

Taylor's non-classical theory of magnetic monopoles as a spontaneously broken $U_{L1} \otimes U_{R1}$ model. Nuovo Cim.Lett. 8 (1973), 513-19.

A unified Bardacki-Weinberg model. Progr.Th.Phys. 50 (1973), 2048-65.

J. T. Lewis and J. V. Pulè:

The equilibrium states of the free boson gas. Comm.Math.Phys. 36 (1974), 1-18.

W. G. Sullivan:

Potentials for almost Markovian random fields. Comm.Math. Phys. 33 (1973), 61-74.

Finite range random fields and energy fields. J.Math.Anal. Appl. 14 (1973), 710-24.

M. M. Carroll and A. C. Holt:

*Steady waves in ductile porous solids. J.Appl.Phys. 44 (1973), 4388-92.

M. M. Carroll and S. C. Chow:

*Motions of proportional extension. Q.J.Mech.Appl.Math. 26 (1973), 471-82.

B. K. P. Scaife:

*Electrical properties of dielectrics. Problems of Physical Electronics, ed. R. L. Ferrari and A. K. Jonscher, Pion, London, 1973. pp.269-96.

*Electrically induced stresses in dielectric fluids. Cooperative Phenomena, ed. H. Haken and M. Wagner (Fröhlich Festschrift), Springer, Berlin, 1973. pp.147-173.

S. Dineen:

*Holomorphic functions on locally convex topological vector spaces. II. Pseudo convex domains. Ann.Inst.Fourier 23 2,5 (1973), 155-85.

Holomorphic functions and surjective limits. Proc.Internat. Conf. on Infinite Dimensional Holomorphy, Lexington, Kentucky, 1973. Springer (Lecture Notes in Math., Bd.364), 1974. pp.1-12.

S. Dineen and P. Noverrez:

Le Probleme de Levi dans certains espaces vectoriels topologiques localement convexes. C.R.Acad.Sci. (Paris) 278 (1974), 693-5.

12. PAPERS ACCEPTED FOR PUBLICATION (in press)

C. Lanczos:

Gravitation and Riemannian spaces. Found.Phys.

J. L. Synge:

Anti-Compton scattering. Proc.R.I.A.

On the present status of the electromagnetic energy tensor. Hermathena.

The science explosion. Nature.

*The hypercircle method. Lanczos Festschrift "Studies in Numerical Analysis". Academic Press.

J. McConnell:

Multiplication of Schur functions. Proc.Internat.Conf.Math. Vancouver, 1974.

Critical notice of "The rules of the game: Cross-disciplinary Essays on models in scholarly thought", ed. T. Shanin, Tavistock Press (London), 1972. Phil.Studies.

L. Ó Raifeartaigh:

Broken gauge and scale invariance. Proc. 1974 meeting of European Math. Phys. Soc., Warsaw.

L. Ó Raifeartaigh and U. H. Niederer:

Realizations of the unitary representations of the inhomogeneous space-time groups. I. General structure. II. Covariant realizations of the Poincaré Group. Fort.d.Phys.

G. B. Mainland:

Poincaré generators for the free spin 3/2 field. Proc.R.I.A.

D. H. Tchrakian:

A formulation of linearized gravity. GRG.

"Electric" and "Magnetic" gravitational fields. GRG.

E. B. Manoukian:

Stability of the eigenvalue for the fine-structure constant and short-distance behaviour in strong interaction. I and II. Phys.Rev.

R. Acharya and Z. Horvath:

Electrodynamic determination of fine structure constant and electron-muon mass ratio from Weinberg's renormalization in group equations. Nuovo Cim.Lett.

T. Garavaglia and J. Gomatam:

The Schrödinger equation in helical coordinates. Commun.Math.Phys.

J. T. Lewis and L. C. Thomas:

A characterization of regular solutions of a linear stochastic differential equation. Z. Wahrscheinlichkeitstheorie.

E. P. Harper:

Unitary pole expansion applied to the trinucleon problem. Phys. Rev.

IV - Annual Report of the Governing Board of the School of Cosmic Physics for the year 1973-74 adopted at its meeting on 4 July 1974.

A. Astronomical Section

1. STAFF AND SCHOLARS

Senior Professor:

P. A. Wayman.

Professor:

T. Kiang.

Research Assistants:

I. Elliott; C. J. Butler (to 31 October 1973).

Experimental Officer:

B. D. Jordan.

Research Associates:

Professor N. A. Porter, UCD; Dr. M. Hoey, UCD.

Technical and Clerical Staff:

Miss A. M. Callanan; Mr. R. P. Murphy; Mr. W. Dumpleton (from 20 August 1973).

Scholars:

P. B. Byrne; M. Stift (from 1 October 1973).

The support of the National Science Council for the Research Assistantship held by C. J. Butler ceased in October 1973. Professor Kiang was granted leave of absence to work at the Department of Astronomy of the University of Glasgow from October 1973 to June 1974.

Dr. M. Hoey, Research Associate, visited the Boyden Observatory in September and October 1973, for observational work.

Dr. M. Stift (Vienna and Geneva) was appointed as a Scholar in the Section from 1 October 1973.

Mr. W. Dumpleton was appointed as a Technical Assistant (photography and electronics) from 20 August 1973. Mr. R. J. Wayman assisted with library re-arrangement in July and August 1973 and Mr. M. McSherry was a Vacation Student for a similar period.

2. RESEARCH WORK

Photometry of Stars: P. A. Wayman, C. J. Butler, M. Stift.

The material derived from the photographic plates measured by the

automatic "Galaxy" machine at the Royal Greenwich Observatory in January 1973 for the region LMC I in the Large Magellanic Cloud has been submitted to reduction procedures developed over previous years and now being adapted for the Nova 1220 competer. The task of identifying stars through their coordinates on the paper tapes has been completed and the process of identification has been found to be efficient. It is apparent, however, that the coordinate transformation adopted during the measuring run with "Galaxy" machine, in order to fix on stars previously identified on another ADH plate, can be sufficiently inaccurate in crowded star-fields that the wrong star is measured as often as one time in two hundred measurements.

The problem of correction for background fog has been studied in detail and a possible method of calculating a correction to "Galaxy" magnitude measures has been derived but not thoroughly tested.

Cepheid Variables: C. J. Butler.

The luminosity relations for cepheids in the Small Magellanic Cloud have been re-computed, yielding slightly different results from those derived earlier. Different selection criteria have been used to exclude "abnormal" cases such as variations arising from multiple stars. The following results ensue:

(1) Period-luminosity relations are virtually unaltered

(2) The mean period-luminosity-colour relation comes close to that derived by Sandage and Tammann

(3) Systematic discrepancies of the order of 0.1 magnitude in brightness apply to cepheids in certain period groups

(4) Period-luminosity-amplitude relations have been derived that are similar to those of Sandage and Tammann.

In (2), the coefficient of $\log P$ is close to the value established theoretically for galactic cepheids, using a range of simplifying assumptions.

The SMC material has now been fully tabulated and a paper written.

Statistical Astronomy: T. Kiang.

Progress was made in applying a new method of correction for observational selection to the asteroid data in the Palomar-Leiden Survey. This work is of particular interest due to a recent suggestion by Ovenden that the regularities of the main features of the solar system ("Bode's Law") would arise naturally if the asteroids are fragments of a former giant planet.

Work has continued on the problems of determining the frequency function for the luminosities of stars and galaxies and of deriving rigorous formulae for the probability of multiple systems being found

in a random distribution of stars on the sky.

Light-Pulse Experiments: P. B. Byrne.

Analysis of the data of May-August 1971 is now complete, with 176 hours of recordings in the vicinity of the galactic centre. Using detailed profiles of over 60% of the 250 timed pulses, practically all are easily ascribed to interpretation as meteor light-pulses. An upper limit to the optical energy flux density accompanying the gravitational pulses reported by Weber has been fixed at 6.10^{-28} watts per square metre per Hertz frequency-interval.

An anomaly occurs in the frequency-distribution of inter-arrival times of individual events on the galactic centre channel. There is an excess of inter-arrival times of less than 1 minute, more than four times the expectation by a Poisson distribution. Instrumental and man-made origins can be virtually excluded by non-occurrence for control regions.

X-ray Sources: P. A. Wayman, P. B. Byrne.

Previous work on optical identifications for SMC X-1 and LMC X-1 has been confirmed by recent data from elsewhere. Preparations are in hand to carry out optical observations of SMC X-1 obtaining spectra and photoelectric photometry simultaneous with X-ray observations. The dates planned for this work are during August 1974, in collaboration with the Mullard Space Science Laboratory (University College, London) which has instruments on board the scientific earth-satellite "Copernicus".

Nebular Emission Lines: M. Hoey.

A joint experiment with Professor A. H. Jarrett of the University of the Orange Free State was carried out at the Cassegrain focus of the 60-inch telescope at the Boyden Observatory during September and October. The experiment was an examination of the internal gas kinematics of the Orion Nebula, using a scanning Fabry-Perot interferometer constructed at University College, Dublin, Physics Department. Emission areas of the Magellanic Clouds were also recorded as a test project and photographic fringes obtained with a solid Fabry-Perot interferometer on the ADH telescope. The results of these observations are being analysed at U.C.D. by Dr. Hoey and appear to be of high quality.

Miscellaneous Work

M. Stift:

Calculations of Oblique-Rotator Models for some magnetic stars have shown that the radii of Ap stars cover the range 2 to 3 solar radii, contradicting a previous result by Preston, who postulated a near-uniform

radius of 3.2 solar radii. An investigation has been started to determine whether a "decentred dipole" model can be applied to all magnetic stars.

C. J. Butler:

A critical appraisal of the work by Thom and Thom on the Carnac stone-age alignments and their alleged astronomical relationships has shown that their interpretations are probably misleading. It is important that the astronomical significance of such remains, which is accepted nowadays by astronomers as genuine, should not be over-stated.

I. Elliott:

Several versions of the Fast Fourier Transform have been implemented on the Nova computer for use in power spectrum analysis on solar data.

3. INSTRUMENTS, ETC.

Mechanical Workshop: R. P. Murphy.

The 16-inch coelostat, structural steel tower, and the associated solar spectrograph and spectroheliograph were dismounted and removed, prior to restoration of the Meridian Room as a Library area. These instruments were used under Professor Brück for contributions to the Utrecht ultra-violet Solar Atlas, and under Professor Ellison for registering spectra of solar phenomena. Up-dating to modern standards of instrumentation was not possible.

Electronics Laboratory: B. D. Jordan; W. Dumpleton.

A new temperature control system with a mercury column thermo-regulator and a solid state switch was developed and installed in the Clock room. A new FM receiver for time signals was constructed.

A high-speed paper tape interface unit for the Nova 1220, compatible with the requirements of the Joyce-Loebl densitometer, was constructed.

Design and development work on a prototype control system for the 2-channel photoelectric photometer at the Cassegrain focus of the 60-inch telescope of Boyden Observatory was carried out. A Matrix programmer and a 24-hour digital clock are used, in conjunction with pulse amplifiers and counters, to give rapid output with automatic sequencing on punched paper tape.

Electronic Computers: I. Elliott.

The IBM 1620 computer was put out of use on 31 March 1974, prior to removal to Dundalk Regional Technical College, where it will be used for instructional purposes. This machine was in use at Trinity College,

Dublin, from 1961 to 1967 and has since then been fully utilised by the School of Cosmic Physics for a great variety of programs; for simple data handling, for Monte Carlo generation of test data, for repeated calculation of gravitational perturbation, and for complex least-squares solutions for non-linear response, among other uses. It has been continuously and well maintained under the maintenance agreement and has performed with great reliability, sometimes being switched on continuously for three weeks or more. Because of the low capital investment, and because operation of the machine could be learned quickly, it was found appropriate to make the machine directly available to users, who were thereby enabled to develop intricate programs rapidly.

The Nova 1220 installation was improved during the year by the addition of a fast paper tape punch, and a doubling of the core storage to 16K words. A new power supply was provided by the manufacturers, in order to overcome the occasional component failures previously experienced. "Extended Basic", "Fortran IV" and "Algol" are the high-level languages available to users.

The Cartrifile loading of core images proves useful, but flexible use of this magnetic cartridge tape for data handling is still not possible because of difficulty in implementing the necessary software.

The extension of the Nova system with use at a terminal for the other Sections of the School, the use of the Department of Finance facility at Kilmainham, and other developments within the Institute, have been considered in formulating plans for the future.

4. MISCELLANEOUS

P. A. Wayman (with Dr. P. S. Florides, TCD):

An exhibition of printed books was arranged from 17 April to 19 May 1973 in the Library, Trinity College, at the invitation of the Librarian and with assistance from Miss M. Pollard, in commemoration of the quincentenary of the birth of Nicholas Copernicus, covering the period up to the time of Newton.

I. Elliott, P. B. Byrne *et alia*:

Arrangements were made for members of the general public to view the nucleus of Comet Kohoutek 1973f with the South Refractor during January 1974. In a succession of clear evenings from January 5 to January 11 over a thousand people were successful in this, even though the brightness of the Comet was much less than had been originally predicted.

M. Callanan and P. B. Byrne:

A library retrieval program for astronomical review articles using key-words has been written for the Nova/Cartrifile system.

I. Elliott and W. Dumpleton:

A method has been implemented of using Contour photography for displaying characteristics of astronomical objects as recorded on photographs. A commercially-available material, "Agfacontour" produces isophotes at a particular level by control of exposure, optical colour filter, and development. The method was found to be adequately reproducible in a variety of applications. Diameters of contours from stellar images constitute measures of brightness of sufficient accuracy for instructional purposes.

5. BUILDINGS

The conversion to library use of the Meridian Room has begun, maintaining as far as possible the original features of the building, which was an early example of an observing room being designed with meteorological factors taken into account.

Part of the outbuildings were set on fire by trespassing youths at 1.00 p.m. on 31 August 1973. The blaze was quickly extinguished, following a prompt arrival of the Fire Brigade, despite an inadequate supply of water for the hoses.

6. LECTURES, VISITS, ETC.

Seven informal seminars took place in the Observatory lecture room during the year including one by Professor D. S. Evans on 8th January. On 9th January, Professor Evans, of the University of Texas, presented the Statutory Public Lecture of the School, with the title "Flare Stars - High Speed Astronomy", at Trinity College, Dublin.

Professor Kiang attended an Advanced Course on Dynamical Structure and Evolution of Stellar Systems at Saas-Fee, Switzerland, 2-7 April 1973. He also attended the Extraordinary General Assembly of the International Astronomical Union held in Poland, 4-12 September 1973, including the I.A.U. Symposium No.63 "Confrontation of Cosmological Theories with Observational Data", in Cracow.

Professor Wayman visited Arizona, California, Texas, Washington D.C., and Massachusetts for a variety of purposes from 16 June to 7 July 1973, including attendance at the dedication ceremonies of the 150-inch Mayall telescope at Kitt Peak National Observatory. He gave an account

of "Abundances in Cepheid Variable Stars of the Magellanic Clouds" at Austin, Texas, on 28th June.

The Boyden Observatory Council Meeting for 1973 was held in Brussels in May and was attended by Professor Wayman.

The Boyden Observatory Council Meeting for 1974 was held in Bloemfontein, Orange Free State, on 29-30 January and was attended by Professor Wayman, who also visited the Radcliffe Observatory, Pretoria, the Leiden Observatory Southern Station, the Sutherland Observatory in the Karoo, part of the South African Astronomical Observatory, and its Cape Town headquarters. He presented an account of "The Motion of Halley's Comet and Planet X" at the Radcliffe Observatory on 18th January.

Professor Wayman spoke on "The Copernican Revolution" in Trinity College on 17 April and on "Modern Methods in Optical Astronomy" in the New University of Ulster, Coleraine, in October, and gave other talks to the Galway Meeting of the Institute of Physics in April, at the Royal Greenwich Observatory, Sussex, in May, to the Antiquarian Horological Society in June, to the Geological Society, T.C.D., in December, and to the Cavan Arts Society in March.

Dr. I. Elliott described the total solar eclipse on the RTE program "Look Around" on 30 June 1973.

P. B. Byrne gave a course of Extra-Mural Studies lectures on Astronomy in University College, Dublin during 1973-74.

C. J. Butler attended the ESRO Summer School in Nottingham in July-August 1973 on the Implications for European Space Programmes of the Possibilities of Manned Missions. A Report was given to the Irish National Committee for Astronomy.

A portion of Moonrock is now held on behalf of the Irish Nation at Dunsink Observatory, having previously been presented by the Apollo 11 astronauts to President de Valéra in 1969.

7. VISITORS

Mr. Richard Burke, T.D., Minister for Education, visited Dunsink Observatory on 15 October 1973, the Senior Professors of the School of Cosmic Physics being present.

Mr. Ritchie Ryan, T.D., Minister for Finance, visited the Observatory on 2 November and 6 January.

Other visitors during the year included Professor and Mrs. D. S. Evans, Professor B. L. van de Waerden, Professor Y. Sachs and the Belgian Ambassador to Ireland.

8. PUBLICATIONS

C. J. Butler and P. A. Wayman:

"Identifications of Variable Stars in the Large Magellanic Cloud", Dunsink Observatory Publications, Vol.1, No.7, 1974 (Communications of the Dublin Institute for Advanced Studies, Series C).

P. A. Wayman:

Composition Data from Variable Stars, Symposium on the New Astronomy, Univ. Orange Free State, 1973.

T. Kiang:

"The Cause of the Residuals in the Motion of Halley's Comet", Mon. Notices, Royal Astr. Soc., 162, 271, 1973 (Contrib. Dunsink Obs. No.11).

S. H. Plagemann:

"On the Angular Distribution of Complete Samples of Bright Quasi-Stellar and Unidentified Radio Sources". Mon. Notices Royal Ast. Soc. 164, 303, 1973 (Contrib. Dunsink Obs. No.12).

C. J. Butler and P. B. Byrne:

"Photographic Photometry of the Proposed Optical Candidate for SMC X-1", Nature Physical Science, 243, 136, 1973.

P. B. Byrne and C. J. Butler:

"A Possible Candidate for LMC X-1", Nature Physical Science, 244, 6, 1973.

P. A. Wayman:

"Notes on the History of Dunsink Observatory III - The Arnold Clocks", Irish Astr. Journ. 10, 275, 1972.

B. D. Jordan:

"A Simple FM Modulator/Demodulator for a Magnetic Tape Recorder", Wireless World, 80, 29, 1974.

B. D. Jordan and B. D. Glazier:

"A 50-Hz Inverter for Mains-Powered Equipment", Irish Veterinary Journal (in press).

M. Stift:

"The Radii of the Ap Stars". Astronomy and Astrophysics (in press).

I. Elliott and W. Dumpleton:

"A new technique for isophotometry", The Observatory (in press).

C. J. Butler:

"Cepheid Variables in the Small Magellanic Cloud", Dunsink Observatory Publications (in preparation).

B. Cosmic Ray Section

1. STAFF AND SCHOLARS

Senior Professor:

C. Ó Ceallaigh, Director of the School.

Professor:

K. Imaeda.

Assistant Professors:

D. O'Sullivan; A. Thompson.

Research Assistant:

Y. V. Rao.

Experimental Officer:

J. Daly.

Technical and Clerical Staff:

Miss D. Molloy; Miss E. Kee, Miss E. Rankin, Miss M. Cahill (from 8 October 1973), Miss C. Murphy (from 8 October 1973), Miss M. McRandal (from 26 July to 14 September 1973), Miss Y. Mitchell (from 12 November 1973 to 25 January 1974), Miss H. O'Donnell, Mrs. E. Ronaldson (to 6 July, 1973), Miss R. Ward (to 31 October 1973).

2. RESEARCH WORK

Study of Very Heavy and Ultra Heavy Cosmic Ray Nuclei:

C. Ó Ceallaigh, D. O'Sullivan, A. Thompson and Y. V. Rao assisted by J. Daly, Miss E. Kee, Miss E. Rankin, Miss M. Cahill (from 8 October 1973), Miss H. O'Donnell, Miss Y. Mitchell (12 November 1973 to 25 January 1974), Miss C. Murphy (from 8 October 1973), Mrs. E. Ronaldson (to 6 July 1973) and Miss R. Ward (to 31 October 1973).

The collaboration with Professor Fowler's group at Bristol University continued very successfully during the year. All of the events found in the Colorado, Nevada and Minnesota stacks (see previous Report) have been completely measured. The batches of Lexan Polycarbonate which were used in these stacks were calibrated by means of Fe Group nuclei. A total of about 500 such nuclei were located, measured and analysed for this purpose. On the basis of this calibration all the ultra heavy cosmic ray events have been identified. In addition to the calibration of the Lexan, work on the calibration of the nuclear emulsion used in the stacks is in progress. To this end, a further 300 Fe group nuclei were located in Lexan and analysed. Each of these nuclei was then followed back into the relevant sheet of nuclear emulsion where its ionisation was comprehensively measured, using microdensitometer equipment.

A total of 120 ultra heavy nuclei has now been accumulated of which 36 have $Z \geq 70$. The primary charge spectrum, extrapolated to the top of the atmosphere, features a sharp peak at $Z = 78$ and large accumulations of events in the intervals $50 \leq Z \leq 60$ and $34 \leq Z \leq 39$. The presence of nuclei with $Z > 83$ and the general form of the charge spectrum for high Z are consistent with nucleosynthesis by the rapid neutron capture process. Although the sample of ultra heavy nuclei contains several events with $Z = 92$, no transuranic nuclei have been detected to date.

The energy spectrum for primary nuclei with $Z \geq 70$ has been measured from the relativistic region down to 0.45 GeV/N at the top of the atmosphere. This spectrum, which is flat, is in excellent agreement with the energy spectrum of cosmic rays of low Z. It should be noted that this result stands in marked disagreement with that of the Berkeley - MSC Collaboration which has reported a very steep spectrum.

A new Dublin/Bristol collaboration stack was constructed during June/July 1973 and exposed in September 1973. The stack profile consisted of 150 sheets of 250 μm Lexan Polycarbonate with one layer of 200 μm G5 nuclear emulsion at the top and a second layer of emulsion between Lexan sheets number 30 and 31. The stack was built as a set of six large modules, each module having a collecting area of 33" x 24". The total weight of the stack was 420 lbs. while the total thickness of detecting material in the stack was 6.8 gm/cm^2 Cu equivalent at 300 MeV/N or 4.8 gm/cm^2 Lexan equivalent at the same energy.

The stack was launched from Sioux Falls, South Dakota on 14th September, 1973 using a Raven 11.1 MCF stratofilm balloon. However, a catastrophic balloon failure occurred during the ascent while passing through the tropopause ($\approx$ 46000 ft altitude). The gondola was recovered near Sheldon, Iowa and fortunately it was not seriously damaged.

A few days earlier, a prototype Raven 31 MCF balloon which had been launched for Bristol University, also failed at the tropopause. Raven Industries Inc. had contracted, as before, to provide two back-up Raven 11.1 MCF balloons in the event of failure of the prototype but had no obligation to compensate in any way for failure of the standard 11.1 MCF balloon used by the Dublin/Bristol Collaboration.

Nevertheless, in view of the circumstances, Raven Industries Inc. decided to provide extra back-up facilities by supplying a 15.8 MCF Winzen balloon free of charge. The refurbished Dublin/Bristol modules were then split up between the 15.8 MCF balloon and one back-up Raven 11.1 MCF balloon made from X-124 film. Both of these flights were successful and the exposures were exceptionally good.

The 15.8 MCF balloon, which carried four of the Dublin/Bristol modules in addition to some other Bristol detectors, remained at ceiling for 82 hours. The mean effective altitude was 3.47 mbars and the gondola was recovered near Cokato, Minnesota on 21st September 1973.

The remaining two Dublin/Bristol modules were assembled into a gondola with other Bristol detectors for the 11.1 MCF balloon which remained at ceiling for 73 hours. In this case the mean effective altitude was 3.60 mbars. The gondola was recovered from shallows in the Mississippi river near Winona at the Minnesota/Wisconsin border on 22nd September 1973.

All the nuclear emulsion from the Cokato and Mississippi flights has been processed and area scanned while the bulk of the Lexan has been ammonia scanned. About 150 square metres of Lexan sheet was etched, as a necessary precursor to the ammonia scan. About 100 ultra heavy candidates have been located and selective etching of the relevant Lexan and measurement of tracks are in progress.

Work has begun on a long term project to investigate the cosmic ray Fe peak in detail. This project will require high precision etching of at least 25 square metres of Lexan sheet and the subsequent location and measurement of up to ten thousand Fe Group nuclei. It is envisaged that this work would continue in parallel with other projects over a period of several years.

Study of the Production of Heavy Nuclear Fragments in High Energy Proton Interactions.

C. Ó Ceallaigh, D. O'Sullivan and A. Thompson assisted by J. Daly.

Most of the nuclear fragments involved in this study have charges and energies which are considerably lower than those of the nuclei involved in the cosmic ray program described above. Consequently, it is necessary to use somewhat different experimental methods, although the basic technique of registration in Lexan is the same. In order to collect a large sample of nuclear fragment events within a practical time scale it is necessary to employ an enhancement system which enables one to determine the ionisation and the residual range of an event simultaneously. Otherwise, it is necessary to re-etch and re-locate each event after its ionisation has been determined, in order to measure its range. This would be impractical for a large sample of events, especially when the density of events per unit area is high.

Several test programmes have been carried out in order to develop an effective system for enhancing the "latent images" of tracks in Lexan by means of UV irradiation. A system has now been developed which increases the track etch rate by a factor of ~ x 100 without causing unacceptable surface damage to the Lexan. The equipment which has been built employs a 1200 watt Hanovia medium pressure mercury arc tube in a jacket of "Duran 50" glass. All radiation with wavelengths shorter than 3100 Å are filtered out and, in practice, the Lexan is irradiated for several days with a UV intensity of about 10 milliwatts per cm^2 in the interval 3100 Å to 4000 Å.

It is intended to use this equipment to further the study of the charge and energy spectra of fragments produced in high energy proton interactions. This work is being carried out in collaboration with the European Centre for Nuclear Research (CERN).

High Energy Nuclear Interactions in Photographic Emulsions.

K. Imaeda.

A theoretical study of nuclear interactions by high energy primary cosmic Rays $6 \leq Z \geq 26$ has been continued. The study is focussed on the creation mechanisms of mesons and nucleons in complex nuclei collisions. The analysis differs from that employed in other current experiments which provide information only on the production of nucleon components such as arise in fragmentation processes. The present analysis is useful in explaining the characteristics of extensive air showers created by heavy cosmic ray nuclei and also throws some light on the origin and properties of high energy galactic electrons and photons.

Application of Statistical Thermodynamic Theory to Nuclear Interactions of Hadronic Matter.

K. Imaeda.

This study has been extended. We consider that the meson cloud around an interacting nucleon is in a state of Einstein condensation characteristic of a boson gas below the critical temperature. The following experimental facts suggest the existence of the Einstein condensed state of the meson cloud around an interacting nucleon. The meson cloud in a condensed state should show superfluidity and elastic scattering can be considered as being due to the superfluidity of the meson cloud. An elastic scattering or a one-pion-exchange interaction takes place according as to whether the meson cloud is in a condensed state or in a normal state. The value of the condensation temperature determined from the one-pion-exchange interactions is in fair agreement with theory.

3. WORKSHOP AND TECHNICAL DEVELOPMENT - J. Daly.

The maintenance of all microscope stations with associated electronic equipment and of the etching plants with associated apparatus was continued during the year. In addition, module shells were fabricated for the balloon flights in September 1973 and specialised equipment was constructed for the research programmes described above.

4. NATIONAL SCIENCE COUNCIL RESEARCH GRANT

An application for a renewal of the Grant for a further period of two years was rejected. The original grant terminated in October 1973.

5. CONFERENCES, MEETINGS, ETC.

The following meetings, international conferences and discussion periods of scientific activity abroad involved members of the Section:

Galway, 7-8 April, 1973 (K. Imaeda, D. O'Sullivan, A. Thompson and Y. V. Rao):
Institute of Physics (Irish Branch) Annual Conference.

Durham, England, 25-27 April, 1973 (C. Ó Ceallaigh):
Conference in connection with the retirement of Prof. G. D. Rochester.

Bristol University, July 1973 (J. Daly, Miss H. O'Donnell and Miss R. Ward):
Construction of detector modules and preparation of stack for projected balloon flight.

Denver, Colorado, 17-30 August, 1973 (C. Ó Ceallaigh, A. Thompson and Y. V. Rao):
To attend the 13th International Cosmic Ray Conference.

Sioux Falls, South Dakota, 31 August - 30 September, 1973 (A. Thompson and Y. V. Rao):
Construction of gondolas, preparation of equipment, launching and recovery of payloads during the 1973 Dublin/Bristol balloon flight expedition.

Bristol University, 28 October - 15 December 1973 (Miss E. Kee and Miss E. Rankin):
Processing of nuclear emulsion and track measurement in nuclear emulsion by means of microdensitometer equipment.

Berkeley, California and Sioux Falls, S.D., 16 January - 31 January 1974 (D. O'Sullivan):
To attend the First Bevalac Users Association meeting in Berkeley, California and to meet representatives of Raven Industries, Sioux Falls, for discussions on the Super-pressure balloon programme.

Bristol University, 11-14 February, 1974 (D. O'Sullivan and A. Thompson):
Collaboration meeting with Prof. P. H. Fowler and his colleagues to discuss the recent progress of the Dublin/Bristol cosmic ray programme and to plan for future balloon flights.

London, 19-22 February, 1974 (D. O'Sullivan and A. Thompson):
Royal Society Meeting: "The Origin of Cosmic Radiation."

Brussels, 26-27 February, 1974 (C. Ó Ceallaigh):
Scientific and Technical Committee (Euratom) Meeting.

Geneva, 25-26 March, 1974 (C. Ó Ceallaigh):
Physics III Meeting at CERN, Geneva.

Brussels, 29 March, 1974 (C. Ó Ceallaigh):
Scientific and Technical Committee (Euratom) Meeting.

Bristol University, 20 March - 11 April 1974 (Miss E. Kee and Miss H. O'Donnell):
Track measurement in nuclear emulsion and associated work.

6. PUBLICATIONS

(a) Published:

D. O'Sullivan, A. Thompson and P. B. Price:

"Composition of Galactic Cosmic Rays with 30 < E < 150 MeV/Nucleon". Nature, 243, 8 , 1973.

C. Ó Ceallaigh, D. O'Sullivan, Y. V. Rao and A. Thompson with P. H. Fowler, R. T. Thorne and A. P. Muzumdar:

"The Charge and Energy Spectrum of Ultra Heavy Cosmic Ray Primaries". Proceedings of the 13th International Cosmic Ray Conference, Denver, Colorado, 5, 3237, 1973.

D. O'Sullivan and A. Thompson with P. B. Price and J. H. Chan:

"Galactic Heavy Cosmic Rays with 5 < E < 130 MeV/Nucleon". Proceedings of the 13th International Cosmic Ray Conference, Denver, Colorado, 1, 146, 1973.

K. Imaeda and A. G. Agnese:

"Two Particle Correlations in the Inclusive Interactions from 50 to 10^5 Gev." Lett. Nuovo Cimento 6, 1973, 415-419.

K. Imaeda and P. Fleming:

"Nuclear Interactions by High-Energy Cosmic Ray Nuclei with light nuclei in Emulsion". Journ. Phys. A. 6, 1973, 1974-1990.

(b) In Preparation:

K. Imaeda:

"Einstein Condensation of Hadron Matter".

7. PERSONAL

Professor C. Ó Ceallaigh was appointed to the Scientific and Technical Committee (C.S.T.) of Euratom for a period of five years and subsequently was elected to the Groupe de Liaison Fusion as one of two representatives of the C.S.T.

Miss E. Kee was promoted to the post of Technical Assistant from 1 July, 1973. Miss D. Molloy was appointed to the position of Clerk of the Section from 1 July 1973.

C. Geophysical Section

1. STAFF AND SCHOLARS

Senior Professor:

T. Murphy.

Professor:

Vacant

Assistant Professor:

D. G. G. Young.

Research Assistant:

P. Morris (to March 31, 1974).

Senior Technical Assistant:

T. J. Morley.

Research Associates:

Rev. G. McGreevy (Maynooth College); R. P. Riddihough (Geological Survey); K. W. Robinson (Geological Survey).

Technical and Clerical Staff:

Miss A. Byrne; Miss E. Ryan; K. Bolster; A. Keogh (to 28 May 1973); G. Wallace (from 10 September 1973).

Scholars:

D. Howard. G. Reynolds.

2. RESEARCH WORK

(a) Gravity:

A limited gravity survey was undertaken in the area between Carrick-on-Shannon and Cavan to complete the regional coverage of Ireland. The complete gravity results including those of Northern Ireland have been given as a coloured contour map drawn up on the scale of 1:750 000 to be published in Communications D.

Dr. Young, after further work in the Kingscourt area assembled and submitted the data for publication. The picture that emerges is one of an early subsidence during lower Carboniferous time controlled by major faults of "caledonoid" trend originating in the pre-Palaeozoic basement. Responding to change in the stress pattern in upper Carboniferous time the north-south trending Kingscourt fault became dominant, initially only in the south, migrating northwards to preserve the narrow wedge of Permo-Triassic sediment near Kingscourt.

The interest of mineral prospecting companies in gravity surveys is still evidenced and many enquiries for data were fulfilled. Such has been the demand that copies of the manuscript maps are now being sold as publications. Requests for guidance have also been made and it became necessary to recheck some of the base stations as over the years the descriptions of the sites no longer apply and in several cases the bases had to be re-sited.

The gravity data have all been transferred to punch cards and thence onto magnetic tape for sorting and computer processing.

The negative gravity anomaly over the silica deposit at Dunshaughlin being investigated by Mr. Reynolds was reinterpreted after a further resistivity survey which showed that a simple relationship between resistivity and depth of burial did not apply. His final analysis using three dimensional model studies indicated a two component structure in the anomalous body. He deduced a process of formation of the silica deposit from the combined geophysical studies along with laboratory simulation of limestone decomposition and incorporated these results in a thesis for the degree of M.Sc.

(b) Magnetics

For some time now various intrusive rocks of deep seated origin have been tested for magnetic effects and Dr. Morris visited many sites in south west Cork and Kerry. Most recorded outcrops, in particular on Beare Island proved non magnetic or only very feebly so in accordance with our experience that intrusive rocks in Ireland of Carboniferous age in general do not produce distinct magnetic anomalies.

From earlier work he followed up certain anomalous readings of magnetic intensity on the Iveragh peninsula and discovered a dyke system running in an almost northerly direction across the southwestern limits of the Dingle, Iveragh and Beara Peninsulas. Palaeomagnetic analysis showed the dyke system to be of Tertiary age. This important discovery has extended the limits of Tertiary volcanic activity by over three hundred kilometres. The findings were incorporated in a paper now in press.

A magnetic survey of Clare Island was undertaken by Dr. Morris in conjunction with geological work being carried out there by Dr. Phillips of Trinity College. It was not completed.

Dr. Young's study of the magnetic survey off the west coast carried out by the Department of Physical Oceanography, University of Wales, culminated in a joint paper (in press). They found that the Slyne Ridge and the Porcupine Bank represent submerged blocks of marginal crust while the Seabight Trough has crust significantly different in character from that beneath these two features and beneath the western Irish Mainland Shelf. Confirmation of this was attempted using explosion seismics described later.

A limited magnetic survey was carried out on the Inishowen peninsula at Moville in an effort to pinpoint certain marked anomalies shown on the published aeromagnetic map of Northern Ireland. The ground survey did not confirm the position of these anomalies on the aeromagnetic map but was more in keeping with what was expected from the earlier gravity work (Report for 1971-2).

In the course of the field exercises for geological students from University College Dublin (see later) unexpected magnetic anomalies were encountered. These were briefly followed up but attempts to locate the causative magnetic rock for sampling were not successful. This unusual occurrence has opened up a new line of enquiry which is being actively pursued.

(c) Meteorology

Routine observations of the meteorological elements were continued throughout the year, the autographic records tabulated and the results published.

Since observations ceased at Trinity College in 1971 due to encroachment of buildings, the present observations are the only open site ones with a long history taken in Central Dublin. Messrs. Morley and Bolster have summarised these and published them in Communications D giving the extremes in temperature, rainfall, sunshine and wind speed.

(d) Seismology

The microseismic noise observed at the seismic station near Malin Head, Co. Donegal was investigated further and the cause was discovered but the mechanism is still not understood. The noise arises from heavy vehicles travelling on a road partly built on wind-blown sand. The energy enters the underlying rock and is readily detected at a kilometre distance. Only qualitative analysis has been undertaken mainly because of repeated breakdowns in the playback apparatus but sufficient records on magnetic tape from multiple sites are available for a full analysis. The frequency of the noise is limited to a narrow, less than 10 Hz, waveband. Special records were taken by the Seismological Unit of the U.K. Atomic Energy Authority at Wolverton of similar noise bursts for our investigation and these indicate a somewhat lower frequency than those at Malin. This study is proceeding.

The collaboration with the Department of Physical Oceanography of the University of Wales was continued and a seismic experiment carried out on the Porcupine Bank and Seabight in an effort to elucidate and compare the structure of both. To this end a short array of seismometers was set up near Castletown Bearhaven and records obtained from depth charge detonated along north-south lines at longitudes 12^{o} 45' and 14^{o} 8'. The primary analysis indicates the different character of the

crust under the Seabight Trough compared with that under the Bank while the crustal thickness appears approximately the same. The signals show that the "first arrivals" consist predominantly of waves in the frequency band 2.5 - 15 Hz, with a peak near 10 Hz, and the group velocity of these under the array is greater than 7 km/s. This indicates that these waves are compressional not surface ones as was originally thought.

Later in the year the same station was reactivated to record large underwater explosions from Scotland and France. An additional station was set up at Dunsink. The largest explosion north-east of the island of Rhum was well recorded at Dunsink (409 km) but most surprisingly barely detected at Castletown Bearhaven (653 km). The frequency of the latter signal was also remarkably high for this distance. The records from the French shots were quite good.

The reasons for the different characters of seismic signals received our special attention and the work is proceeding.

(e) Palaeomagnetism

The spinner magnetometer used for the palaeomagnetic work heretofore located in the Physics Department of Trinity College was replaced by a commercial model linked to a DIGICO micro computer installed in the laboratory. This gives directly the basic remanent magnetic characteristics of a sample and the corresponding palaeopole.

The auxiliary apparatus necessary for a full palaeomagnetic investigation of rock samples was reconstructed by Mr. Howard to improved designs using parts from the old apparatus. The A.F. demagnetiser is now capable of producing a maximum flux density of 0.13T and is thus suitable for demagnetising almost all igneous rocks.

The construction of the new thermal demagnetiser was commenced and is in progress. A high sensitivity susceptibility meter was made from parts of the replaced spinner magnetometer. It is capable of detecting susceptibilities as low as 10^{-8} and can be used to detect anisotropy effects.

The principal work undertaken by Mr. Howard was an endeavour to establish an ancient pole position for the Devonian period which could then be used for dating purposes. To this end a large number of rock samples both sedimentary and igneous were collected from rocks attributed to the Lower, Middle and Upper Devonian systems. A preliminary analysis, mainly of the igneous members, showed a real possibility of establishing unique pole positions for the Lower and Upper Devonian.

A minor study was made of Tertiary igneous dykes occurring in the Curlew mountains. The palaeomagnetic analysis showed that they have three different polarisations indicating three different phases of injection. Two of the polarisations are 'normal' being the first

encountered in Ireland. This is considered a discovery of scientific and practical importance.

(f) Rock Sample Data

The data have been analysed, sorted and assembled into a publication by Dr. Morris.

(g) Earth currents measurements

In the course of his investigation of the Dunshaughlin deposit mentioned earlier, Mr. Reynolds, while applying resistivity methods, also recorded Spontaneous Polarisation effects. Several of the measurements showed a significant correlation between S.P. and resistivity which varied with the azimuth of the electrode array and the magnitude of the S.P. gradient. In some instances the measurements of S.P. could substitute for the resistivity data. Other locations were visited with similar results. In view of the unsatisfactory nature of the explanations given for the S.P. phenomenon this could be an important clue. More work is planned along this line.

3. LECTURES AND FIELD EXERCISES

A series of six weekly lectures on geophysics was given for geological students from the Universities during the Michaelmas term by members of the staff. Owing to other commitments only students of Trinity College were able to attend.

Field geophysical exercises were held for the geological students in two sessions. One for Trinity College students in Co. Mayo and the other for University College Dublin students in Co. Kilkenny. All the geophysical techniques at our disposal were demonstrated and sample surveys undertaken by the students. Unexpected results were encountered in both instances which will be of great interest to geologists.

4. CONFERENCES

European Geophysical Society, Zürich, September 25-28, 1973 (Murphy and Young).

5. PUBLICATIONS

(a) Published:

T. J. Morley and K. Bolster:

The Climate of Dublin City, extremes of temperature, rainfall, sunshine and wind speed. Comm.Dub.Inst.Adv.Stud., Series D, No.30.

P. Morris:

Density, magnetic and resistivity measurements on Irish rocks. Comm.Dub.Inst.Adv.Stud., Series D, No.31.

D. G. G. Young:

The Donegal granite - a gravity analysis. Proc.R.I.A., 74B, 63-73.

D. G. G. Young and R. J. Bailey:

A reconnaissance map of the continental margin west of Ireland. Comm.Dub.Inst.Adv.Stud., Series D, No.29.

(b) In Press:

P. Morris:

A Tertiary dyke system in southwest Ireland. Proc.R.I.A., 74B.

D. G. G. Young and R. J. Bailey:

An interpretation of some magnetic data off the west coast of Ireland. Geological Journal.

Gravity Map of Ireland. Comm.Dub.Inst.Adv.Stud., Series D, No.32.

(c) Submitted:

D. Howard:

Deep seated igneous intrusives in Co. Kerry, Ireland. Proc.R.I.A.

T. Murphy:

Geophysics: Chapter 15 in A Geology of Ireland. Irish University Press.

D. G. G. Young:

A geophysical interpretation of the structural development of the Kingscourt graben. Proc.R.I.A.

W. B. Stanford
CHAIRMAN.

9th September, 1974